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11. TITLE (Include Security Classification): RF Communications Laboratory Renewal

12. PERSONAL AUTHOR(S): Dr. Douglas B. Miron

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17. COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This was an equipment purchase grant under the DoD-URIP program. The objective was to equip the Lab to cover signal generation and measuring in the UHF band, and provide an antenna test facility. The necessary hardware was acquired, installed, and tested. The Lab is now functional.

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22a. NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE NUMBER (Include Area Code)	22c. OFFICE SYMBOL
Dr. Witt	(202) 767-4931	NE

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Technical Report

RF Communications Laboratory Renewal

When the actual amount of money available became known, it was decided that a compromise between frequency range and functional coverage was necessary. It was determined that a broader range of research topics could be served by narrowing the frequency range and broadening functionality as much as possible. To this end, the UHF band was chosen as the focus frequency range. Equipment was selected and acquired, for the most part, which has some degree of capability in this band. For support purposes, some pieces which only function at HF or below were also acquired.

This grant was solely for equipment purchase, so no research was conducted under it, and none is hereby reported. However, the Lab has already been used to support M.S. research projects.

The period over which this work has extended was much longer than expected. Two main reasons for this are excessive paper delay in procedures which require detailed authorization before a purchase rather than accountability afterwards, and a scarcity of qualified personnel to do the antenna positioner installation. This installation, which was completed in January, 1987, required placing steel beams in the lab building roof to withstand the 10,000 ft.-lb. torque rating of the positioner.

All proposed equipment has now been acquired, tested, and installed. A prospectus for the Lab was written last year, and is attached. Also attached are lists of the equipment purchased with the grant, and equipment donated and purchased with University money for the matching requirement under the grant agreement.

D. B. Miron

D. B. Miron

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Total.....203,254.00

Date	Equipment with description	Company	Cost
	High frequency oscilloscope system	Tektronix	
2/5/85	(1) voltage probe (demo)		605.00
	(1) 7104 oscilloscope (demo)		21,570.00
	(1) 7A29 plug-in unit (demo)		2,630.00
	(1) 7B10 " " " "		2,240.00
	(1) 7A22 " " " "		1,380.00
2/19/85	(1) voltage probe 010-6201-01	Tektronix	1,210.00
	transportation		5.15
3/5/85	(1) time base plug-in unit 7B15		2,695.00
	(1) amplifier " " " 7A29-04		2,855.00
	(1) signal delay		415.00
	transportation		21.02
7/22/85	(1) HF Receiver WJ8718A	Watkins-Johnson	6,080.00
11/6/85	(1) VHF/UHF Receiver WJ 86178	Watkins-Johnson	28,210.00
	Following items from	Scientific Atlanta	
12/2/85	(1) antena positioner 53230-17		51,545.00
	(1) positioner controller NSP H116 B-10		4,610.00
	(1) antenna pattern recorder NSP 1581-3-6-9		18,480.00
	(1) Two axis synchron. display NSP 1844-2		4,310.00
	(1) 12' cable 5051		848.00
	(1) cable 092436		168.00
	(1) cable 162962		341.00
	freight		463.70
	Following items from	Hewlett-Packard	
1/6/86	(1) Manual 10 DB Step attenuator option 001		890.00
	(1) VHF coaxial step attenuator 355D		1,050.00
	(1) VHF coaxial step attenuator 355C		350.00
	(1) coaxial dir. coupler 11692D		8,145.00
	(1) coaxial coupler 778D		2,850.00
	(1) RF plug in 83525A		13,540.00
	(1) sweep oscillator 8350B		4,565.00
	(1) synth. signal generator 8656B		6,500.00
	(1) high stability time base option 001		850.00
	(1) network analyzer 8410C		6,997.50
	(2) DC power supply 6234A		900.00
	(1) DC power supply 6286A		1,050.00
	(4) DC power supply 6216B		1,480.00
2/6/86	(3) step attenuators		2,670.00

MATCHING FUNDS

Item Name	Model Number	Inventory Number	Price
Network Analyzer	8410A	D12654	4760
Interface & Polar Display	8419A 8414A	D13455	910 2705
Sweep Oscillator	8690B	D13452	1275
S-Parameter test set	8745A	D13453	6251
Oscilloscope (less plugin)	7704	D13182	3150
Oscilloscope	7504		3262 3000
Plug in unit(2)	7A11		3400
2 plug in units	7A15		917
Multimeter	HP3478A	D11405	1375
Frequency Convertor	HP8411A		2,500
Phase Magnitude Display	HP8412B		3,699
Slotted Line	General Radio	38419	354
Scope Mobile Model 500A	Tektrmix	38419	250
6 Benches		@200	1,200
3 Shelves			100
1 Rol-a-Lab storage cabinet			150
5 Padded laboratory stools		@100	500
1 Metal laboratory stool			20
Frequency Counter	D10483	HP 5340A (11,500)	7,702
		Total	47,480

5/13/86	(3) crystal detectors 423A	Hewlett Packard	660.00
	phone calls		17.97
6/9/86	x 1 oscilloscope probes	Tektronix	56.66

SOUTH DAKOTA STATE UNIVERSITY
Box 2220
Brookings, SD 57007-0194

Department of
Electrical Engineering
(605) 688-4526

THE RF COMMUNICATIONS LABORATORY AT SOUTH DAKOTA STATE UNIVERSITY

A Prospectus

In 1984, SDSU received a DoD-URIP grant to renew our RF Communications Lab. This project will be completed by Fall, 1986. The outcome of the effort will be a facility capable of performing many functional tests on circuits and antennas in the VHF-UHF range. The equipment acquired under the grant, and some previously donated, includes signal and sweep generators, receivers, analyzers, a frequency counter, a gigahertz 'scope system, 50 ohm detectors, directional couplers, step attenuators, miscellaneous bench power supplies, and an antenna positioner and pattern recording system. This equipment is listed and briefly described in an attached table, and the frequency coverage is shown in an attached figure. In addition, we have some older, but still useful, items such as sampling and vector voltmeters, slotted lines, an rf bridge, a Q meter, octave directional couplers, etc. The EE Dept. also has a Hybrid Microelectronics Laboratory in which thick- and thin-film circuits can be built.

The principle faculty member for the RF Lab is Dr. Douglas B. Miron. His background in electrical engineering is very broad, including some experience in broadband rf design, antenna arrays, electrically small and active antennas, and numerical methods. In addition, other faculty members available to support projects in connection with the Lab are Dr. Robert G. Finch and Dr. Guang-Wen Pan. Dr. Finch has a background in hardware design and communications theory. Dr. Pan has recent experience in numerical solution of scattering problems and electromagnetic effects in Very-High-Speed Integrated Circuits. He is joining us this Fall. The resumes of these faculty are attached.

We offer these facilities and faculty to serve you in almost any arrangement you may desire. We welcome complete projects, joint or cooperative development, or subcontracts. Write or call at any time:

Dr. Douglas B. Miron
EE Dept. 2220
SDSU
Brookings, SD 57007

605-688-4016, campus office
605-688-4526, EE Dept.
605-692-7977, home

EQUIPMENT

HP8656B-001 Signal Generator
0.1-990 MHz. -127 to +13 dBm in 0.1 dB steps. Internal AM and FM. High-stability time base. Programmable.

HP8350B/83525A Sweep Generator
0.01-8.4 GHz. Leveled power from -2 to +13 dBm. External AM and FM. Internal crystal or external markers. Start-stop or delta-frequency sweep modes.

WJ8718A HF Receiver
5 kHz-30 MHz. Detectors; AM, FM, CW, USB, LSB, ISB. Five IFs; 0.3, 1, 3.2, 6, 16 kHz. BFO. Synthesized tuning, 10 Hz min. step.

WJ8617B HF-UHF Receiver
2-1100 MHz. Detectors; AM, FM, CW, PLS, SSB. IFs; 3.2, 50, 300, 8 MHz. Synthesized tuning, 10 Hz min. step. BFO. Separate antenna inputs and front ends split at 500 MHz. Programmable. Spectrum display and connector output.

Scientific Atlanta 53230A-17 Antenna Positioner
Azimuth over elevation. 10,000 ft-lb torque, 10,000 lb. direct load. Rotary joint, 40-line slip rings, rf switches.

Scientific Atlanta

4116A-10	Positioner Controller
1844-2	Two-axis Synchro Display
1580-3-6-9	Antenna Pattern Recorder

HP8410C/8411A/8412B Network Analyzer
0.11-12.4 GHz. Magnitude range on test channel -10 to -75 dBm. Phase/magnitude display. Resolution 1 dB/cm and 1 deg/cm.

HP8410A Network Analyzer System
0.1-4 GHz. Polar display.

HP8745A S-Parameter Test Set
0.1-2 GHz. Transistor fixtures.

HP5340A Frequency Counter
10 Hz-18 GHz. Min. signal level -35 dBm. Max. power 1 W into 50 ohms.

Tektronix 7104 Oscilloscope System
4 bay, 1 GHz mainframe.
7A22 Diff. Amp. 10 uV/cm, 1 MHz
7A29 Single channel, 5 mV/cm, 1 GHz.
7A29-04 As above, with variable delay line.
7B10 Time base.
7B15 Delayed time base.
Two FET probes, 500 MHz.

HP423B Crystal Detectors
Three, 50 ohm type N rf terminating. 0.01-12.4 GHz.
>0.5 mV/uW sensitivity. 0.2 W max. input.

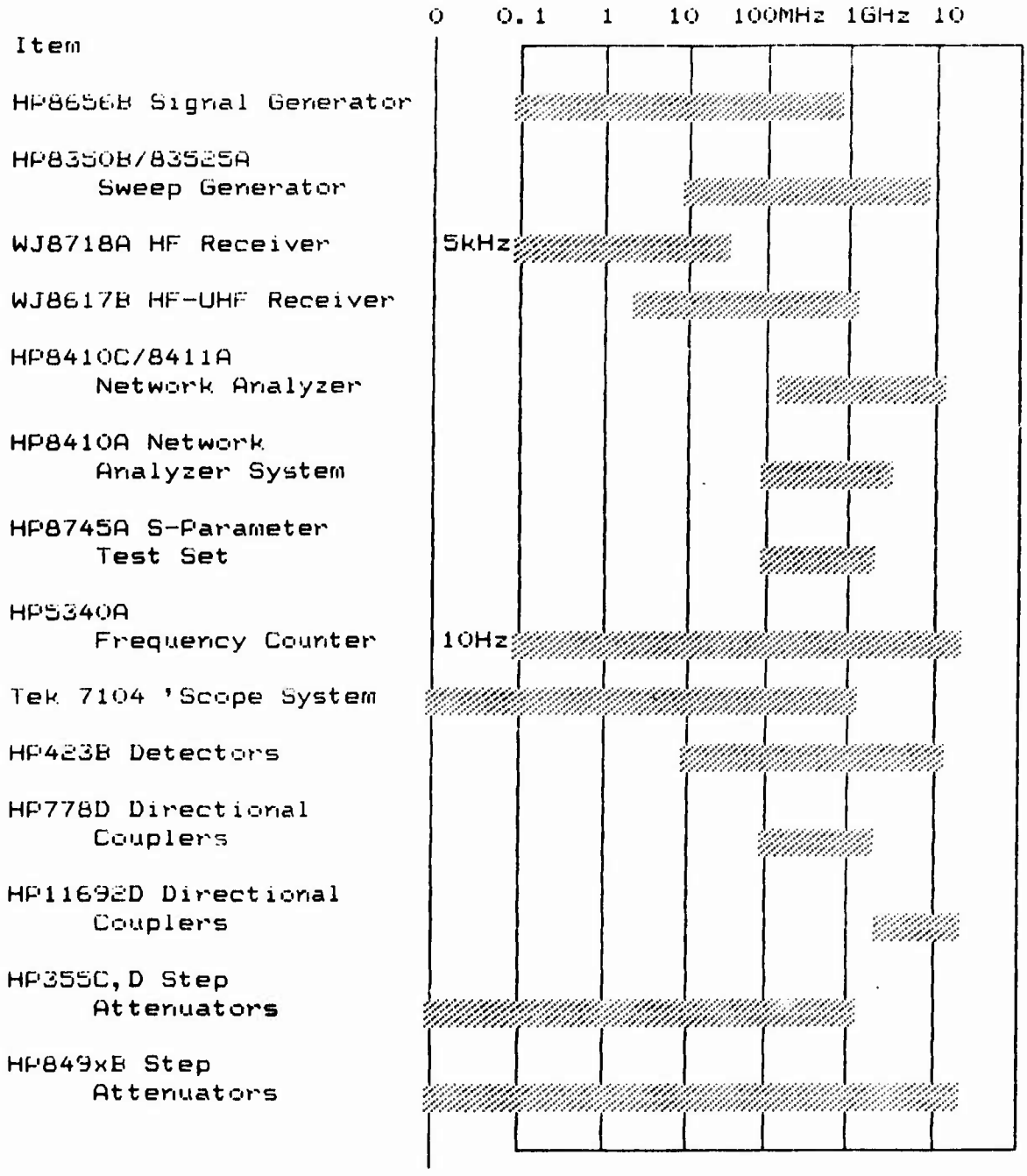
HP778D Dual Directional Couplers
Three, 0.1-2 GHz, -20 dB coupling. 50 W.

HP11692D Dual Directional Couplers
Three, 2-18 GHz, -22 dB coupling. 50 W.

HP355C,D Step Attenuators
0-1 GHz. 0.5 W. One 1 dB/step, two 10 dB/step.

HP8494B/8496B Step Attenuators
0-18 GHz. 1 W. One 1 dB/step, two 10 dB/step.

RF LAB EQUIPMENT FREQUENCY COVERAGE



RESUME

Miron, Douglas Bernard 9 June 1986

EDUCATION

Yale University New Haven, Connecticut	9/57-6/63	B.E. (E.E.) 1962 M.E. (Controls) 1963
U. of Conn. Storrs, Connecticut	9/67-5/77	Ph.D. (Controls) 1977

MEMBERSHIPS

IEEE, Eta Kappa Nu, Registered Professional Engineer in South Dakota.

LANGUAGES

Currently using English, IBM PC BASIC, FORTRAN, APL. Used to know French, Russian, German, IBM 1620 and HP 9100 machine languages, PL/1, various BASICS.

EMPLOYMENT

6/63-8/65 Pratt and Whitney Aircraft Division
United Aircraft Corp.
East Hartford, Connecticut

Duties: The Scientific Staff was a consulting group for other engineering groups engaged in advanced power systems research. As a result, I worked on a wide range of problems from circuit design through analysis of gas flow controls to analysis of the dynamics of a nuclear power heat transfer system.

9/65-7/67 Electric Boat Division, General Dynamics Corp.
Groton, Connecticut

Duties: The Underwater Development Section was mainly concerned with small research submarines. We also designed trainers and rendered assistance to other engineering groups. Problems handled here were such things as coordinate transformations for sonar, underwater visibility, motor control, battery gas testing, etc. The largest project was one for a proposal. I designed a computer program which simulated the design of a search and rescue submarine, ran it through a test mission and evaluated its cost/effectiveness. I supervised two programmers and coaxed scaling and performance information out of numerous engineers. The program worked, but Lockheed got the contract.

9/70-8/72 Bio-Engineering Institute
University of New Brunswick
Fredericton, New Brunswick
Canada

Duties: Circuit design for latest generation of myoelectric instrumentation.

9/72-1/73 South Norwalk Electric Works
South Norwalk, Connecticut

Duties: SNEW is a generation and distribution system owned by the people of South Norwalk. As their latest piece of generation arrived, their consulting electrical engineer was hurt in a tractor accident. I was hired to supervise the installation and checkout of the electrical and control systems for a new diesel-driven 5 MW unit. It was their first pushbutton startup unit and has many automatic features. There were several vendors, so it was necessary to examine drawings and equipment for compatibility. In addition, I did some buy-or-generate strategy and contract studies, designed a load-shedding system, and wired an emergency start-up generator.

4/74-7/79 Hermes Electronics Ltd.
Dartmouth, Nova Scotia
Canada

Duties: At Hermes, I was mainly concerned with applications and improvements of high-frequency active receiving loop antennas. During my stay, I designed the interface circuits for a circular array; developed algorithms for calculating the responses of ideal and nonideal circular arrays; and applied modern data processing methods to the art of HF direction finding. I was also occupied with production and customer support.

10/79-present Department of Electrical Engineering
South Dakota State University
Brookings, South Dakota 57007

Rank; Associate Professor. I regularly teach the courses in Electromagnetic Fields, RF Electronics, and Linear Control Systems. I have also taught the circuits, electronics, and basic systems courses. My current research interest is in current density calculations on broad-surface antennas. I am also supervising graduate students working on the Vector Processor, and voltage-controlled oscillator development.

Summer 1981 E. F. Johnson Co.
Waseca, Minnesota

Duties: Developed an internal antenna for the 850 MHz band hand-held radiotelephone.

Summer 1984 IBM Corp.
Rochester, Minnesota

Duties: Extend an existing math model for predicting the bit-error rate for a magnetic disk data storage system.

PUBLICATIONS

"Circular Array Response; Theory and Calculations" Hermes Technical Report TR 75/1, 1975

"Theory for Application of a Circular Array" Hermes Technical Report TR 75/17, 1975

"Common-Mode Response of a Rectangular Loop in a Vertical E-Field" Hermes Technical Report Tr 75/21, 1975

"Application of Supergain to Hermes Linear Arrays" Hermes Technical Report TR 76/14, 1976

"Noise Calculation for Active Receiving Antennas" Hermes Technical Note TN 76/34, 1976

"Effect of Ground Reflections on Active Receiving Antenna" Hermes Technical Note TN 77/7, 1977

"Loop Preamplifier Development-1978" Hermes Technical Report TR 78/18, 1978

"N to One Hybrid Converters" Hermes Technical Note TN 79/19, 1979

"Low Noise Amplifier for Myoelectric Measurements" Medical and Biological Engineering, January, 1973

"Image Motion on the Retina" Am J. of Optometry and Physiological Optics, Vol. 53, No. 8, August, 1976

"Improvement of Ocular Resolution in the Presence of Nystagmus" Ph.D. Thesis, University of Connecticut, 1977

"Digital Data Processing Applied to HF DF by Phase Measurement" Canadian Electrical Engineering Journal, April 1978

"The Singular Integral Problem in Surfaces" IEEE Trans. on Antennas and Propagation, vol. AP-31, no 3, May 1983

"Survey of Recent Results for the Simgularity Problem in the Electromagnetic Integral Equation" Proceedings of the North Dakota Academy of Science Vol. 38, p30, April, 1984

ROBERT G. FINCH

PII Redacted

[redacted]

Office Telephone: 605-688-5217

EDUCATION

Ph.D. Purdue University 1974
Major: Electrical Engineering
Minor: Mathematics
Area of Specialization: Communications
Thesis Title: Spectrum Utilization Efficiency
Thesis Advisor: Dr. George R. Cooper

M.S.E.E. Michigan State University 1960

B.S.E.E. Michigan State University 1958

TEACHING EXPERIENCE

Professor 1984-
Associate Professor 1978-1984
Assistant Professor 1974-1978
South Dakota State University
Graduate Courses Taught - communications, digital signal processing, fiber optics
Undergraduate Courses Taught - communications, signal and system analysis, probabilistic methods, integrated circuits, electronics, linear circuits, electromagnetic field theory, basic electrical engineering

Graduate Instructor 1967-1974
Purdue University
Taught undergraduate electrical engineering lecture courses in the areas of signal and system analysis, probabilistic methods, and linear circuits. Also, taught in a self-paced circuits program.

ENGINEERING EXPERIENCE

Engineer Summer-1983,84
IBM Corporation - Rochester, MN
Conducted a study of methods used for simulating and testing VLSI circuits with emphasis on mixed technology (analog/digital).

Communication Systems Analyst Summer-1977,78,81
TRW Defense & Space Systems Group - Redondo Beach, CA
Worked as a systems analyst on the Tracking and Data Relay Satellite System. Specific areas investigated were antenna

placement, cycle slipping of phase-locked loops, phase noise, effect of RFI pulses on automatic level control system, modeling of a TWT amplifier to study AM-to-AM and AM-to-PM effects resulting from RFI pulses, interference between users in a multiple-access system, and doppler error due to phase noise.

NASA-ASEE Summer Faculty Fellow — Summer-1975,76
Johnson Space Center - Houston, TX
Worked on the analysis of a spread spectrum communication system for the Space Shuttle Orbiter. Also conducted tests on a prototype spread spectrum receiver.

Research Assistant, Research Associate — 1961-1967
Radio Astronomy Laboratory, University of Michigan
Worked on the design of low-noise radiometers that were flown as part of rocket and satellite experimental packages. Served as project engineer for the radiometer flown on the OGO-E satellite. Duties included circuit design, mechanical design of package, specification and procurement of components to insure high reliability, environmental testing, and liaison with Goddard Space Flight Center, and TRW Systems during integration of package onto the spacecraft.

Design Engineer — 1960-1961
Bendix Systems Division - Ann Arbor, MI
Worked on the design of high frequency bandpass amplifiers and varactor frequency multipliers.

PROFESSIONAL DEVELOPMENT

Fiber Optic Communication Systems Short Course — 1983
University of California at Santa Barbara

Mini-sabbatical — 1976
University of Connecticut

HONORS AND ACTIVITIES

Professional Societies:
IEEE - Information Theory Group
Communications Society
Acoustics, Speech, and Signal Processing Society
Education Society
ASEE

Honor Socities:
Eta Kappa Nu

GUANG-WEN (George) PAN

PII Redacted

[redacted]

Tel. (605) 688-4223 (W), [redacted]

[redacted]

EDUCATION:

1984 Ph.D in Electrical Engineering, University of Kansas (with GPA=4.0/4.0)

1982 M.S. in Electrical Engineering, University of Kansas (with GPA=3.98/4.0)

1967 B.E. in Mechanical Engineering, Peking Institute of Petroleum Technology

EXPERIENCES:

August 1986 - Present

1. Associate Professor in Electrical Engineering Department, South Dakota State University

2. Technical Cosultant, Mayo Foudation

May 1985 - August 1986

Research Engineer in Mayo Foundation:

Theoretical Modeling and Computer Simulation of High Speed LSI/VISI and Interconnections

1. The Transmission Line Approximation (Quasi-TEM Assumption) for Two- and Three-Dimensional Multi-conductor/Multilayered Dielectric Systems

2. The Wave-Scattering Approaches with Higher Modes i.e.,Non-TEM Modes Considered

3. Transient Analysis and Wavefront Simulation of Coupled Lossy and Dispersive Transmission Lines

Oct. 1984 - May 1985

Post Doctoral Fellow, The University of Texas at Arlington:

1. Airborne Radome Design and Analysis
   (1) Ray Tracing Method
   (2) Surface Integration Method
   (3) Plane Wave Spectrum Analysis
   (4) Numerical Techniques: Finite Element, Method of Moments

2. Electromagnetic Wave Scattering from Randomly Rough Surfaces: the Fung-Pan Approximation

1980 - 1984
Graduate Research Assistant with Space Technology Center (NASA Contractor), University of Kansas:

1. Radiometric and Radar Remote Sensing
   (1) Inverse Techniques
       Least-Square Solution
       Constrained Linear Inversion
       Optimal Estimation Method
       Statistical Inversion Method
       Backus-Gilbert Synthetic-Averige Inversion
   (2) Atmospheric Sounding by Satellite Radiometers
   (3) Atmospheric Profile Retrieval from Ground-Based Observation

2. Electromagnetics
   (1) Field Computation by the Method of Moments
   (2) Rough Surface Scattering
       Integral Equation Method
       Kirchhoff Approximation (Physical-Optics)
       Small Perturbation Model (Rice Model)
       Extinction Theorem Method
       Stochastic Fourier Transform Method
   (3) Volume Scattering
       Born Approximation
       Renormalization Method
       Diagram Method
   (4) Radar System Design
       Side-looking Airborne Radar (SLAR)
       Synthetic Aperture Radar (SAR)

3. Applied Mathematics and Numerical Techniques
   (1) Wiener Filtering
   (2) Kalman Filtering (Fast Algorithm)
   (3) Polynomial Regression and Curve Fitting
   (4) Numerical Integration and Differentiation

4. Communication
   (1) Information Theory and Application
   (2) Digital Communication Systems
   (3) Microwave Communication Systems
   (4) Satellite Communication System Design
       K-Band SS-TDMA(Spacecraft-Switched Time Division Multiple Access)
       SCPC, FDMA/FM, CDMA

5. Digital Image Processing and Pattern Recognition
   (1) Image Restoration and Enhancement
       Adeptive Filtering; Constrained Least Square

   (2) Pattern Recognition: Feature Selection by Karhunen-Loeve Expansion and by Nonlinear Mapping; Nonparametric Estimation; Clastering

1970 - 1978
Engineer, Institute of Development and Research, Chang-Qing Oil Field, China

1. Analog Circuit Design

2. Digital Circuit Design

1967 - 1970
Associate Engineer, Yumen Oil Field, China
1. Mechanical Design

AWARDS AND ACTIVITIES:

1982 Calhoun Fellowship from Drexel University

1981 Chinese Representative in President Truman's Memorial Feast

1978 New Invention Prize form Ministry of Petroleum Industry, China. (for leadership of the group that developed a digital remote fire system for oil seismic exploration.)

PUBLICATIONS AND PROPOSALS:

Pan, G.W.,"Crop Classification Using a Nonlinear Mapping Algorithm," NASA Contract NAS 9-15421, Remote Sensing Laboratory, University of Kansas, 1982.

Pan, G.W. and A.K. Fung,"The Integral Equation Method for Rough Surface Scattering," RSL-TR-592-10 under NASA Grant NAGS-268, Remote Sensing Laboratory, University of Kansas, Sep. 1984.

Pan, G.W., A.K. Fung and J.S. Bagby,"A Study Plan for a Computerized Radome Design Program," (Prepared for the General Dynamics Fort Worth Division, two-year contract with budget $163,734) University of Texas at Arlington, Jan. 1985.

Fung, A.K. and G.W. Pan,"A Rough Surface Scattering Model for the Entire Frequency Range," Presented on the International IEEE/AP-S Symposium, Vancouver, Canada, June 1985.

Pan, G.W. and A.K. Fung,"Radome Geometry Description," Wave Scattering Research Center, TR474-1, University of Texas at Arlington, June, 1985.

Fung, A.K. and G.W. Pan,"An Integral Equation Method for Rough Surface Scattering," Presented on the International Symposium/Workshop, July 29 - Aug. 1, 1985. Pennsylvania.

Gilbert, B., G.W. Pan and D. Schwab, A Plan of Study for High Speed GaAs IC's Electromagnetic Simulation. (Prepared with budget $341,000 for 3 years) Nov. 1985.

Pan, G.W. and A.K. Fung,"Region of Validity of Surface Current Approximation," submmitted to IEEE Trans. Remote Sensing and Geophysics.

Fung, A.K. and G.W. Pan,"A Simple Scattering Model for Broad Band Roughness Spectra,"submitted to IEEE Trans. Remote Sensing and Geophysics.

Gilbert, B., G.W. Pan, et al.,Modeling Simulation and Testing of Integrated Circuits, Final Report to Wright Patterson Air Force Base, September 1986

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